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M Prema
PG Scholar, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Department of Livestock Products Technology, Veterinary College and Research Institute, Orathanadu, Thanjavur District, Tamil Nadu, India

M Anna Anandh
Professor and Head, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Department of Livestock Products Technology, Veterinary College and Research Institute, Orathanadu, Thanjavur District, Tamil Nadu, India

Corresponding Author:
M Anna Anandh
Professor and Head, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Department of Livestock Products Technology, Veterinary College and Research Institute, Orathanadu, Thanjavur District, Tamil Nadu, India

Quality of dietary fiber enriched chicken meat cutlets incorporated with raw plantain pseudostem powder

M Prema and M Anna Anandh

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Abstract
A study was conducted to evaluate the effect of raw plantain pseudostem powder (RPPP) on the physicochemical characteristics, proximate composition and sensory acceptability of functional chicken meat cutlets. In the experimental formulations, cooked mashed potato, used as the conventional extender, was partially replaced with RPPP at levels of 5%, 10%, and 15%, while cutlets prepared with 100% cooked mashed potato served as the control. Incorporation of RPPP significantly ($P<0.05$) increased emulsion pH, emulsion stability, product pH, breading pickup, moisture retention and cooking yield compared with the control. In contrast, oil uptake decreased significantly ($P<0.05$) with increasing levels of RPPP incorporation, indicating improved fat-barrier properties. However, diameter shrinkage was not significantly affected (P>0.05) by the incorporation of RPPP. Significant differences ($P<0.05$) were also observed in the proximate composition of the cutlets with respect to moisture, protein, fat, ash and crude fibre contents. Sensory evaluation revealed that cutlets incorporated with 10% RPPP exhibited the highest numerical scores for appearance and colour, flavour, juiciness, tenderness, crispiness and overall acceptability, although these scores were comparable (P>0.05) to those of the control and 5% RPPP treatments. However, incorporation of 15% RPPP significantly ($P<0.05$) reduced sensory scores. Based on the results of the present study, it was concluded that cooked mashed potato could be replaced with 10% RPPP in the preparation of chicken meat cutlets without adversely affecting product quality and sensory acceptability.

Keywords: Chicken meat cutlets, dietary fibre, plantain pseudostem powder, sensory quality, acceptability

Introduction
Functional foods have received considerable attention in recent years owing to increasing consumer awareness of the relationship between diet, health and disease prevention (Anna Anandh *et al.*, 2003)[3]. Among these, dietary fibre-enriched meat products have attracted growing interest because of their potential health benefits, including improved gastrointestinal health, enhanced satiety and a reduced risk of chronic diseases. In addition to their nutritional advantages, dietary fibres can improve the technological and functional properties of meat products by enhancing water-holding capacity, emulsion stability, cooking yield and oxidative stability (Selvakumar *et al.*, 2024) [14]. Plantain pseudostem is an abundant agricultural by-product generated after the harvesting of banana bunches and is generally discarded as waste. However, it is a rich source of dietary fibre, essential minerals, and bioactive compounds with antioxidant properties (Padam *et al.*, 2014) [12]. Utilization of raw plantain pseudostem powder (RPPP) as a functional ingredient in meat products offers dual benefits by improving product quality and nutritional value while contributing to the sustainable utilization of agricultural waste and reducing environmental pollution associated with its disposal (Hazarika *et al.*, 2026) [10]. Chicken meat cutlets are popular ready-to-eat convenience products prepared from minced chicken meat, spices, condiments, and extenders. These products are widely accepted by consumers because of their desirable flavour, texture and palatability (Anna Anandh, 2019) [4]. Incorporation of fibre-rich ingredients such as plantain pseudostem powder into chicken meat cutlet formulations may improve physicochemical properties, nutritional quality and sensory characteristics owing to their high water-binding and oil-retention capacities. However, information regarding the utilization of raw plantain pseudostem powder in chicken meat cutlets is limited.

Therefore, the present study was undertaken to evaluate the effect of raw plantain pseudostem powder on the physicochemical characteristics, proximate composition, and sensory quality of functional chicken meat cutlets.

Materials and Methods

Chicken meat

Fresh chicken meat was procured from a local poultry processing unit. Visible fat and excess connective tissue were manually trimmed and removed. The cleaned meat was then cut into small uniform pieces and frozen for 2 hr to firm the muscle tissue and facilitate efficient mincing. Subsequently, the chilled meat pieces were minced twice using a mechanical meat mincer fitted with a 5 mm plate to obtain a uniform texture suitable for cutlet preparation.

Raw plantain pseudostem powder

Fresh plantain pseudostems were collected from local agricultural fields. The outer fibrous layers were manually removed to obtain the tender inner core, which was then cut into small uniform slices. The slices were dried in a hot-air oven at 60°C until a constant weight was attained to ensure complete dehydration. The dried material was subsequently ground using a mechanical grinder and sieved through a fine mesh to obtain a uniform and free-flowing raw plantain pseudostem powder (RPPP).

Formulation of chicken meat cutlets

The control chicken meat cutlet formulation was prepared using mashed cooked potato as the extender without the incorporation of raw plantain pseudostem powder (RPPP). In the treatment formulations, RPPP was incorporated at levels of 5%, 10% and 15% by replacing an equivalent proportion of the mashed cooked potato extender. Each formulation also contained salt (1.5%), dry spice mix (2.0%), condiment mix (10.0%), vegetable oil (3.0%) and bread crumbs (2.5%). The condiment paste consisted of onion, garlic, and ginger in a ratio of 3:2:1.

Preparation of chicken meat cutlets

Minced chicken meat was thoroughly mixed with raw plantain pseudostem powder (RPPP) according to the respective treatment formulations. The minced meat was thoroughly mixed with breadcrumbs, condiments, spices, salt and other ingredients until a uniform batter was obtained. Portions of approximately 50 gm were shaped into oval cutlets using moulds. Separately, the condiment mixture and spice blend were lightly sautéed in a small quantity of oil to enhance the release of flavor and aroma compounds before being incorporated into the meat mixture. The resulting mixture was blended uniformly until a homogenous batter was obtained. Portions weighing approximately 50 gm were then shaped manually into uniform oval-shaped cutlets. The formed cutlets were subsequently chilled to improve structural stability and handling characteristics. For coating, the chilled cutlets were dipped in beaten whole egg and evenly coated with bread crumbs. Finally, the coated cutlets were deep-fat fried in refined oil until a characteristic crisp golden-brown crust developed.

Physico-chemical analysis

The effect of raw plantain pseudostem powder (RPPP) on chicken meat cutlets was evaluated through physicochemical analysis, proximate composition analysis and sensory evaluation. The pH values of both the raw emulsion and cooked product were measured using a calibrated digital pH meter. Technological properties, including emulsion stability, breading pickup, cooking yield, moisture retention and oil uptake were determined using standard food analysis procedures (Anna Anandh, 2019) [4]. Dimensional stability of the cutlets during frying was assessed by measuring diameter shrinkage before and after deep-fat frying using a digital vernier caliper (Ahamed *et al.*, 2007) [2]. Proximate composition analysis was carried out according to AOAC (1995) [5]. Methods to determine moisture, crude protein, crude fat, total ash, and crude fiber contents.

Sensory evaluation

Sensory evaluation of the cooked cutlets was conducted by a semi-trained panel comprising university faculty members and postgraduate students under controlled laboratory conditions. The panelists evaluated appearance and color, flavor, juiciness, tenderness, crispiness and overall acceptability using a 9-point hedonic scale, where a score of 1 indicated “extremely undesirable” and a score of 9 indicated “extremely desirable” as per the method described by Keeton (1983) [11].

Statistical analysis

To ensure experimental reliability and reproducibility, the entire experiment was conducted in four independent trials. The data obtained were subjected to statistical analysis using analysis of variance (ANOVA) procedures as described by Snedecor and Cochran (1989) [15].

Results and Discussion

Physico-chemical characteristics

Physico-chemical characteristics of functional chicken meat cutlets incorporated with raw plantain Both emulsion pH and cooked product pH increased significantly ($P<0.05$) with increasing levels of raw plantain pseudostem powder (RPPP) incorporation. This increase might be due to the mineral-rich composition and relatively alkaline nature of plantain pseudostem powder (Abdul *et al.*, 2011) [1]. Emulsion stability values also showed a significant ($P<0.05$) increase with higher levels of RPPP incorporation, which might be due to the enhanced water-binding and fat-binding capacities of the dietary fiber present in the pseudostem powder, thereby improving emulsion stability (Carballo *et al.*, 2021) [7].

Technological properties such as breading pickup, moisture retention and cooking yield increased significantly ($P<0.05$) with increasing levels of RPPP incorporation. The improved moisture retention observed in the treatment groups might be associated with the high water absorption and retention capacity of dietary fiber present in the pseudostem powder (Carballo *et al.*, 2021) [7]. A similar finding was also reported by Raju *et al.* (2019) [13] for banana pseudo stem flour-incorporated cutlets. Therefore, an increase in cooking yield could be due to the ability of the composite flour to retain moisture and fat in the matrix, resulting in minimal nutrient loss during cooking. In contrast, oil uptake values decreased significantly ($P<0.05$) as the level of RPPP increased. The reduced oil absorption might be attributed to higher moisture retention and the formation of a compact fiber matrix during deep-fat frying, which could restrict oil

penetration into the product. The possible reason for this phenomenon includes fibers in banana Pseudo-stem flour, which enhance the ability to absorb and retain oil while forming a matrix that effectively holds onto oil (Hansi *et al.*, 2024) [9]. Diameter shrinkage was not significantly affected by the incorporation of RPPP, indicating that replacement of cooked mashed potato with pseudostem powder did not adversely influence the dimensional stability of the cutlets during frying (Raju *et al.*, 2019) [13]. Significant differences ($P<0.05$) were also observed in the proximate composition of the products. Moisture and fat contents decreased significantly, whereas crude protein, ash and crude fiber contents increased significantly with increasing levels of RPPP incorporation. The present results are in agreement with the results of Ayoub *et al.* (2022) [6]. The increase in crude fiber content confirms the successful development of a fiber-enriched chicken meat cutlet.

Table 1: Physico-chemical characteristics of functional chicken meat cutlets incorporated with raw plantain pseudostem powder (Mean ± S.E)

Physico – chemical charaterisctics	Control chicken meat cutlet	5% raw plantain pseudostem powder incorporated chicken meat cutlet	10% raw plantain pseudostem powder incorporated chicken meat cutlet	15% raw plantain pseudostem powder incorporated chicken meat cutlet
Emulsion pH	6.12 ± 0.10^{a}	6.24 ± 0.12^{b}	6.32 ± 0.10^{c}	6.40 ± 0.12^{d}
Emulsion stability (%)	84.62 ± 0.16^{a}	86.84 ± 0.14^{b}	88.92 ± 0.18^{c}	90.48 ± 0.16^{d}
Product pH	6.04 ± 0.12^{a}	6.16 ± 0.10^{b}	6.24 ± 0.12^{c}	6.32 ± 0.10^{d}
Breading pickup (%)	12.48 ± 0.14^{a}	13.26 ± 0.12^{b}	14.12 ± 0.10^{c}	14.96 ± 0.12^{d}
Moisture retention (%)	58.42 ± 0.16^{a}	60.86 ± 0.14^{b}	63.18 ± 0.18^{c}	65.44 ± 0.16^{d}
Oil uptake (%)	9.84 ± 0.12^{d}	8.92 ± 0.10^{c}	8.04 ± 0.12^{b}	7.18 ± 0.10^{a}
Cooking yield (%)	90.82 ± 0.18^{a}	92.46 ± 0.16^{b}	94.24 ± 0.14^{c}	95.88 ± 0.18^{d}
Diameter shrinkage (%)	8.42 ± 0.14	8.36 ± 0.12	8.30 ± 0.10	8.24 ± 0.12
Moisture (%)	63.82 ± 0.16^{a}	62.48 ± 0.14^{b}	61.12 ± 0.18^{c}	59.84 ± 0.16^{d}
Protein (%)	18.24 ± 0.14^{a}	18.86 ± 0.12^{b}	19.42 ± 0.16^{c}	20.08 ± 0.14^{d}
Fat (%)	12.84 ± 0.12^{a}	11.96 ± 0.10^{b}	11.18 ± 0.14^{c}	10.42 ± 0.12^{d}
Ash (%)	2.18 ± 0.10^{a}	2.42 ± 0.12^{b}	2.68 ± 0.10^{c}	2.94 ± 0.12^{d}
Crude fiber (%)	0.42 ± 0.06^{a}	1.84 ± 0.08^{b}	2.96 ± 0.10^{c}	4.12 ± 0.12^{d}

*Number of observations: = 6
Means bearing different superscripts row-wise differ significantly ($P<0.05$).

Sensory characteristics

The sensory characteristics of chicken meat cutlets incorporated with varying levels of raw plantain pseudostem powder (RPPP) were evaluated for appearance and color, flavor, juiciness, tenderness, crispiness and overall acceptability. Sensory scores for appearance and color were significantly ($P<0.05$) higher in cutlets incorporated with 10% RPPP and were comparable to those of the control group. However, further increase in the incorporation level to 15% resulted in a significant decline in appearance and color scores, which might be attributed to the development of a darker crust during deep-fat frying.

Table 2: Sensory characteristics of functional chicken meat cutlets incorporated with raw plantain pseudostem powder (Mean ± S.E)

Sensory Characteristics**	Control chicken meat cutlet	5% raw plantain pseudostem powder incorporated chicken meat cutlet	10% raw plantain pseudostem powder incorporated chicken meat cutlet	15% raw plantain pseudostem powder incorporated chicken meat cutlet
Appearance and colour	8.2 ± 0.12^{a}	8.1 ± 0.10^{a}	8.3 ± 0.12^{a}	7.6 ± 0.10^{b}
Flavour	8.1 ± 0.10^{a}	8.0 ± 0.12^{a}	8.2 ± 0.10^{a}	7.4 ± 0.12^{b}
Juiciness	8.0 ± 0.14^{a}	8.1 ± 0.12^{a}	8.3 ± 0.10^{a}	7.5 ± 0.14^{b}
Tenderness	8.2 ± 0.12^{a}	8.2 ± 0.10^{a}	8.4 ± 0.12^{a}	7.6 ± 0.10^{b}
Crispiness	8.0 ± 0.10^{a}	8.1 ± 0.12^{a}	8.3 ± 0.10^{a}	7.4 ± 0.12^{b}
Overall acceptability	8.1 ± 0.12^{a}	8.2 ± 0.10^{a}	8.5 ± 0.12^{a}	7.6 ± 0.10^{b}

**Number of observations: = 42
**Sensory attributes were evaluated on a 9-point hedonic scale (wherein 1 = extremely undesirable and 9 = extremely desirable)
Means bearing different superscripts row-wise differ significantly ($P<0.05$).

Flavor scores remained comparable to the control up to the 10% incorporation level but decreased significantly ($P<0.05$) at 15% RPPP incorporation. The decline in flavor acceptability at higher incorporation levels may be due to the pronounced vegetal flavor imparted by the pseudostem powder, which could have masked the characteristic flavor of the chicken meat cutlets. Juiciness and tenderness scores were significantly ($P<0.05$) higher in the 10% RPPP treatment group. This improvement might be associated with the enhanced moisture retention and water-binding capacity of the dietary fiber present in the pseudostem powder, which helped maintain product softness during cooking. Similarly, crispiness scores were significantly ($P<0.05$) higher in cutlets incorporated with 10% RPPP, possibly due to improved crust formation during frying. Overall acceptability scores were significantly ($P<0.05$) higher in the 10% RPPP-incorporated cutlets and were comparable to the control treatment. In contrast, the 15% incorporation level resulted in lower sensory scores because of adverse effects on color, flavor and texture characteristics. Chakraborty *et al.* (2021) [8] also reported a reduction in sensory scores for the appearance, aroma, taste, texture and overall acceptability of biscuits as the proportion of banana pseudostem substitution in wheat flour biscuits in

the formulation increased. Based on the sensory evaluation, it was concluded that raw plantain pseudostem powder could be incorporated at a level of up to 10% in chicken meat cutlets without adversely affecting product quality or consumer acceptability.

Conclusion

Based on the evaluation of physicochemical and sensory characteristics, it may be concluded that raw plantain pseudostem powder (RPPP) can be effectively incorporated at a substitution level of up to 10% in the formulation of functional chicken meat cutlets. Incorporation at this level improved emulsion stability, moisture retention, cooking yield, crispiness and crude fiber content while reducing oil uptake, without adversely affecting the sensory quality or overall consumer acceptability of the product. Therefore, RPPP was found to be a promising functional ingredient for the development of fiber-enriched meat products with enhanced technological and nutritional properties.

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